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THE WATER SUPPLY PROBLEM IN A COMBAT DIVISION ¹

BY LUCIUS A. FRITZE ²

It was the good fortune of the author to have participated in the World War as Water Supply Officer for the famous 42d or Rainbow Division, as well as to have been Commanding Officer of the Divisional Field Laboratory, and later, the Water Supply Officer for the American Third Army, the Army of Occupation in Germany. It is upon experiences gained during this service that he is able to coordinate his impressions of the task of supplying water to an army division in active service.

A brief résumé of the life of the Rainbow Division may not be amiss, for from it can be judged the experience of practically all other American units which served at the front. This division was the third complete divisional organization to land upon French soil. It was organized at Camp Mills, Long Island, N. Y., in August and September, 1917. It sailed for Europe in the middle of October, and all the organizations of the division had been debarked in France early in November. Then came several months of training, until the early part of February, mastering the finer points of modern warfare under the instruction of the French. After this the real work commenced, with 110 days without relief in the trenches of the Luneville and Baccarat sectors.

On March 20 the Germans had commenced the desperate and enormous effort to reach the French capital, and the British and French armies shook under the strain. On the 3d of July the 42d went into its first major operation in the chalk-fields of the Champagne. Here the division remained in the trenches until the morning of the fifteenth of July, when the last great offensive of the German army broke against the French and the Americans. After

¹ Read before the Iowa Section at Mason City, October 22, 1919. Discussion of this paper is requested and should be sent to the Editor.

² With Wallace & Tiernan Co., Inc., 349 Broadway, New York; recently Captain, Sanitary Corps, A. E. F.; Water Supply Officer, Rainbow Division; Water Supply Officer, Army of Occupation.

four days of battle this effort was halted and the division was transferred to Chateau Thierry, in the great counter-offensive which was launched by the Allies on the morning of the 18th. Here ensued almost one month of continual horror because of the sickening heat, the frightful destruction in both life and property, and the difficulties attending the transportation of almost all necessities of life to the men in the fighting line.

From this engagement the organization went to a rest area for five days, and then, after a march of ten days, to immediate participation in the advance and taking of the hitherto impregnable St. Mihiel salient. This battle lasted for four days, but the division spent until the 30th of September holding the front line trenches. Then came the supreme American effort in the Argonne Forest, during which the Rainbow fought twice and ended its fighting history on the 11th of November, by capturing the keystone position of the German Army, the City of Sedan.

After a few days of much needed rest, the long march into Germany commenced, and by the middle of December, the troops took position on the left bank of the Rhine as elements of the Army of Occupation. There followed four months of welcome inactivity until orders in April sent the Division to the United States.

From this résumé it may be seen that the problem of supplying water of a potable character to an infantry division during its many phases of activity is in itself unique. In this organization of 28,000 men, sometimes scattered over a wide area, and then again congested into a close formation, it was necessary to have a definite organization with prescribed responsibility to maintain the certainty of pure water for both men and animals.

The life cycle of a division may conveniently be divided into five phases, represented as follows: first, in the training area; second, on the march; third, in stationary trench warfare; fourth, in rest area after action; and fifth, in active battle.

To properly present the various conditions that confront the Water Supply Officer of a Combat Division, it is necessary to take up each of these phases separately. Thus, in the first phase, which is the life in the training area or camp, the work of this officer is of a comparatively simple nature, since the water is usually taken from the mains of the nearest city or town which has a potable supply, or from a developed local supply in the camp. As a rule, such work is cared for either by the Quartermaster Corps or the Engineer Corps.

The water is purified in the same manner as in the best municipal plants, and only requires a periodical examination by the Water Officer to assure its potability. It so happened in the training areas in France that the troops were billeted in a large number of small towns, since it was impractical to construct at that time cantonments for so large a body of troops. In this case, with so many sources of supply exposed to surface pollution, it was necessary to investigate each and every supply used by the men.

The Army supplied each company, 250 officers and men, with two canvas water bags, commonly known as Lyster bags. Previously issued orders required that all water used by the men for drinking purposes should be sterilized in these bags. Within the division the organization supervising this routine was the Divisional Field Laboratory. Sufficient personnel from this unit was constantly engaged in the investigation of the sources of supply and making the necessary chemical and bacteriological examination of the water. Since it was impossible for the men of this organization to oversee this at all times, it was the duty of the battalion medical officer to insure that the orders in this regard were carried out, and that one man from each company was assigned to the duty of filling these bags and taking care of the sterilization. By this means, in the training areas, potable water was constantly available for all the men.

The second phase of a division's activity is on the march. During such periods it is impossible for one man to investigate each source of water, so the responsibility for the selection of sources rests with the medical officer or officers on duty with the individual organization. If question arose as to the desirability of using certain water, the divisional Water Officer was called for consultation. In France, of course, the roads had all been traversed at one time or another by the French Army and the French medical and sanitary units had labeled most of the water supplies as to the safety or danger attending their use, but since in many cases these signboards had been put up as much as two years before, it was necessary to make a general survey to determine whether or not the water was still potable. A simple chemical procedure using starch iodide solution enabled the investigating officer to determine roughly if any great amount of pollution was present.

These two briefly described phases have entailed no great amount of effort and no insurmountable obstacles to the Water Supply Officer because the source of water has always been in those towns or villages

where members of the civilian population were living and using the water daily, thus giving some guarantee of its purity. The next phase, however, or the phase of trench warfare, presented quite a different aspect. Here the civilian population had been evacuated from within a distance of five miles of the front line trenches, the towns were in most instances damaged or destroyed by shell-fire and many of the water sources covered by debris or grossly polluted by passing troops. Into this area representing approximately six to nine miles of trenches and extending eight miles to the rear, were stationed 28,000 men. It may be positively said that there was not one single source of pure drinking water to be found in the area of the trenches. All were condemned at first hand. Open springs were subject to two sources of contamination, one from fecal matter, and the other from gas shells which had impregnated the soil thereabout.

This situation presented a problem rather difficult to overcome, but three methods were found which were successful. The best wells near the trenches were lined with concrete and a heavy concrete cover placed over the top to protect them from gas shells. This method enabled the troops to obtain satisfactory water, if it was sterilized, quite near the front. Since, however, these wells afforded water only to the troops in the immediate locality, it was necessary to have pipe lines laid, by Engineer troops, from known water sources back of the zone of shell fire, to make up for the deficiency of supply. Again a narrow gauge railway permitted water, sterilized in the rear, to be brought up to various points of advantage along the front. Animal-drawn water wagons then took it the intervening distance to the company kitchens. By these means water for the Lyster bags which were hung in the rear trenches was obtained. The troops in the line filled their canteens from these bags.

Troops leaving one of these nerve-racking, front-line sectors after having been under an intense strain for a varying period of time, went to the rest area. Here the situation was much the same as in a training area, for water was easily obtained, but the condition of the men after such a gruelling experience was very different. They were worn out by sleepless days and nights, constantly on the alert for eventualities, jarred by the concussion of exploding shells, and presented an easy prey for pathogenic bacteria to which, in an ordinary condition of health, they would have had a considerable resistance. Hence the problem of supplying a safe drinking water assumed a doubly important aspect. Sanitary surveys, bacteriological exam-

ination, chemical examination and practically every known means of water control were used. Even with all precautions and care being employed, it was almost impossible to prevent the occurrence of sporadic cases of illness due to the drinking of polluted water in the rest areas.

We have seen in a general way the problems encountered in maintaining sufficient and safe water for a Combat Division during its ordinary existence. We now reach the time when the organization puts forth its supreme effort in battle. As a body of troops swung along to take up position in a drive against the enemy, the men were in a nervous mood. Sometimes thoughtlessly, and then again with the "don't care" attitude, all the precautionary measures for the sterilization of the drinking water were not fully carried out. The water supply as found along the front was used. If the Engineers had developed and established definite water points with proper sterilization, these points were the sources of supply. If, however, very little preliminary work had been done in the preparation of suitable sources, any satisfactory supply was used.

With the heavy concentration of men found in a battle line, wherein a complete division occupied a sector approximately two miles in width, all the water supplies were grossly polluted despite all precautionary measures. Unsterilized water was used. When the zero hour was reached and the first waves of infantry went over the top, the problem of maintaining satisfactory drinking water became most difficult. With the terrible destruction of life, wastage, and decomposition, it was an almost impossible task to obtain it. Again, those supplies which looked most attractive might have been poisoned by the enemy, though in the experience of the author no source was found by him which seemed to have been deliberately poisoned. This remarkable circumstance, that all waters were not intentionally poisoned, seemed to be due to the fact that the Germans had been on the offensive so long that when on the defensive they did not appreciate the seriousness of their position until too late.

After the troops had passed over that desolate stretch of ground called "No Man's Land," and had extended the lines several miles beyond, the problem of getting the necessary water purification supplies across that waste presented great difficulties. In the meantime, the task of checking water supplies for the presence of free poisons and maintaining potable water for the troops was practically impossible. With the water supply organization established in the Rain-

bow Division, which made every conscientious effort that suggested itself or could be suggested, and could not realize perfect success, the enormous obstacles attending this may be appreciated. Nevertheless, by untiring effort and investigation, both by night and day, information was gained by the laboratory which proved to be of immense aid to the troops even in the heat of battle. And there can be no doubt, that the very presence of men in the field who were continually alert to the dangers of contaminated water, and who were constantly warning the medical officers of real and suspected dangers, had much to do with the attention which was given by the troops to this matter. In this way the Divisional Field Laboratory justified its existence at the scene of an active engagement.

Usually each soldier carried sufficient water to last for the first twenty-four hours of battle, but with canteens being punctured and lost, there were times when the men were forced by their extreme thirst to drink the water from shell holes, which often contained the corpses of both dead men and animals. Sometimes, as in the Battle of Chateau Thierry, when the Engineers did not succeed in developing water points nor a potable supply from the available sources, this water from the shell holes was consumed for a number of days in succession. The consequence was a heavy outbreak of diarrhoea and dysentery. It may be said that the typhoid and paratyphoid prophylaxis saved our army from most serious epidemics of these diseases. As it was, in some battles, upwards of half a command was afflicted with diarrhoea of a more or less serious nature, and many were incapacitated for duty.

Since this battle was fought during the months of July and August, in a period of intense heat and untold swarms of flies, a vicious cycle was established; made up by the primary drinking of grossly polluted water, then a severe diarrhoea, and the completion of the cycle by the plague of flies which carried the infectious matter to the food-stuffs. To combat this condition with the very limited facilities in the field, it was necessary to adopt an emergency measure, which may not meet with the approval of all sanitarians, but which proved itself to be a successful remedy at the time. This consisted in adding to the water what would have been considered in ordinary times a gross excess of chlorine, approximately 12 parts per million. Although such a large amount of this substance caused the water to be unpalatable, its use at meal times so sufficiently sterilized the food as to prevent the infection of those who were still healthy. The records

of the Medical Department of the Division will bear out the statement that the diarrhoea was halted. In fact, this method proved so valuable that its later use with even more strongly chlorinated water, was adopted by some of the surgeons as a cure for chronic diarrhoea, with success.

In contrast to the indescribable conditions which existed during the battle of Chateau Thierry, which was an emergency offensive on the part of the French and Americans, and for which no time had been given to sufficiently prepare, the battle of St. Mihiel, which was carefully planned, presented an organized front with sufficient water points developed. Here the Engineers had surveyed the area and located at proper places steri-labs and chloro-pumps, and from maps had ascertained the sources of water in the area behind the German lines, and even provided the equipment for immediate installation when the American troops had gained this ground, so that in the very rapid advance sterile water would be obtained.

Nevertheless when the battle broke, and the troops advanced their lines some 8 kilometers the first day, and ultimately reached positions 22 kilometers distant from the jump-off, a period of three days elapsed before potable water could be supplied from definite water points. During this time the Divisional Laboratory concentrated its effort on the work of determining the presence of free poisons in the water, and the selection of certain sources as satisfactory supplies for the use of the troops until the Engineers had time to bring up their equipment and establish water points. The Lyster Bags were used with considerable success, and although there were a number of cases of diarrhoea, the improvement was very marked as compared with the battle of Chateau Thierry. Likewise in the Argonne Forest, after the troops had advanced the battle line a considerable distance beyond "No Man's Land," there was a period of two or three days elapsing before the Engineers were able to supply potable water from definite water points. It can safely be said that the first three days of battle represent chaos in an organized effort to supply water from established sources.

The question immediately arises as to how this condition can be overcome, or, if not overcome, ameliorated during the initial stages of a great drive. The fact that the American people are the greatest water-drinking people on earth necessitates that each soldier be provided with more water than is now permitted with the small army canteen. Increasing the army canteen to twice its present size,

though it increases the weight the men must carry, would supply water enough to last two days.

The French discovered the necessity of this early in the war, for they used at that time a canteen containing one liter. At the first battle of the Marne the water or wine was soon consumed and during the days of retreat that followed, men in their raging thirst, drank from ditches at the roadside, and a few kilometers farther dropped out because of acute diarrhoea or dysentery, and in this condition were captured by the enemy. Seeing the importance of this, the French commanders immediately authorized the manufacture of a 2-liter canteen, and this was used with great satisfaction during the remainder of the war. It must be realized in this connection, however, that the French soldier was issued a wine ration daily rather than water, and the quantity of wine necessary to quench thirst is much less than water, so that the water-drinking American soldier was at a proportionately greater handicap in the hard conditions of an advance.

In addition to this, the regiment of Engineers assigned to each combat division should include in its personnel sufficient engineers familiar with water supply work to meet the exigencies arising. It is the opinion of the author that, by following these two recommendations, the terrible situation always found during the early stages of battle would be greatly relieved.

Even as this war was the most enormous war that has ever been fought by man, and its improvements in man-killing devices superior to those of any other war, so too have been developed in a like degree man-saving devices. The great scourge of the wars of all ages past was typhoid fever and its kindred malady para-typhoid. Whole armies have been decimated by these diseases, and bullets were never to be more feared. In most cases, these were water borne diseases and it was never found possible to eliminate them from the water nor to arrest their invasion of the human system. The discovery, however, of the typhoid and para-typhoid prophylaxis, together with the chlorine sterilization of drinking water, has laid low this terror, with the result that the American Army during this war has never been seriously affected by them. We have not as yet, however, found the means to prevent the entrance of the many low-grade organisms which caused the diarrhoea so prevalent in our major operations in France. No one of these could be actually said to be the causative organism, but all seemed to conspire to produce the

illness. There is, for this reason, no possibility of producing an artificial immunity to them. The diarrhoea was not a fatal disease except in rare cases, but yet it incapacitated so many men in the fighting line that it became a very dangerous enemy. The only way found to prevent this diarrhoea was the constant sterilization of the drinking water by one means or another.

To meet this situation and maintain a supply of drinking water in which the bacteria causing this very troublesome diarrhoea is eliminated, requires the services in each Division of an organization with a personnel trained in the control and purification of water supplies. During the recent emergency, in the hasty organization of our army, a field laboratory was assigned to each division for the purpose of caring for the investigation and control of water. Unfortunately, since the duties of this organization were not prescribed, it was not able to function in all instances with complete success. The primary function of the laboratory was the control of the water supply and the investigation of communicable diseases. It was unfortunate in many instances, however, that men were assigned as officers to these laboratories who knew nothing of the practical nature of water control and purification. The reason for this was, that these officers were for the most part men who were doctors of medicine, trained in the methods of clinical diagnosis and cure of disease but lacking the technical knowledge of water so necessary in this field of work.

It is now recognized that during the past decade the field of medicine has outgrown the bounds of the hospital and the clinic. Advances have been made so rapidly in all forms of science that the graduate of a medical school is not and can not be expected to have mastered all the ramifications of the science of medicine, such as advanced bacteriology, chemistry, the X-ray, sanitary engineering, public health administration and the control of water and milk supplies. There are highly skilled experts in each of these fields who do not possess the degree of M.D. and have very little necessity for it. This condition was seen rather tardily by the army in the emergency, but it was met as well as possible by the creation of a new corps, subordinate to the medical corps, which gathered to the commissioned personnel those men whose knowledge and skill would have been thrown away either as non-commissioned officers of the medical department, with no real power or authority, or squandered in the infantry.

The emergency is past, the victory is ours, and now the army has returned to its peace-time size. Our participation in the struggle was rich in experience, but it does not seem that the full benefit of this experience is being realized. The medical department has returned to almost its peace-time status, but yet no provision has been made for a future emergency by the inclusion in its organization of a separate and distinct corps of non-medical, scientific experts whose services proved so valuable during this war.

It is the purpose of the author in presenting this matter at this time, and before this organization, because of its importance to the army and the country, that effort be made to have legislation enacted providing for the organization of such a corps within the Medical Department of the United States Army.